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QUEENSLAND

BUREAU OF SUGAR EXPERIMENT STATIONS

DIVISION OF ENTOMOLOGY

. . . BULLETIN No. 6 . . .

The Cane Grubs of Australia

PART II.

*Being a continuation of the results
of investigations as commenced in
Bulletin No. 2*

By

A. P. DODD

Assistant Entomologist

1917



BRISBANE

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Bureau of Sugar Experiment Stations,
Brisbane, 30th November, 1917.

The Under Secretary,
Department of Agriculture and Stock,
Brisbane.

SIR,—I have the honour to submit for publication Bulletin No. 6 of the Division of Entomology of the Bureau of Sugar Experiment Stations entitled "The Cane Grubs of Australia," by Mr. A. P. Dodd. This is a continuation of Bulletin No. 2 by Girault and Dodd. It has been revised and corrected by Dr. J. F. Illingworth.

I have, &c.,
HARRY T. EASTERBY, General Superintendent.

Approved:
E. G. E. SCRIVEN,
Under Secretary.

The Cane Grubs of Australia

By A. P. DODD

Part I.—Descriptive Matter.

The following table is a recapitulation of Girault and Dodd's, with the addition of several new species, the omission of several others, and the correction of some wrongly-given characters; also changes have been made in the order of the table and the mutual relations of the species, the breeding of many hitherto unconnected larvæ establishing their relationships. The larvæ omitted in this present table are Nos. 364, 349, 539, and 607; of these No. 364 belongs to the *Coprides*, and No. 349 is the Lucanid, *Cladognathus torrensis* Deyr. The added larvæ are *Lepidiota caudata*, *Lepidiota* sp. No. 683, *Lepiliota* sp. No. 615, *Lepidiota* sp. No. 10, *Anoplognathus* sp. No. 686, *Isodon puncticollis*, and No. 625. Of the larvæ whose identity have been established through breeding, No. 377 is *Lepidiota rothei*, No. 89 is *Anomala australasiae*, No. 646 is *Heteronyx* sp., No. 609 is *Epholcis bilobiceps*, Nos. 587 and 650 are species of *Haplonycha*, No. 678 is *Semanopterus depressiusculus*, and No. 576 is *Horonotus optatus*.

In Girault and Dodd's table, p. 4, line 11 from bottom, it is stated, "second lobe of abdominal segments 2-6 smallest, longest at the meson," and this statement occurs also in the description of *Xylotrupes australicus*; in all the species the incisions of the abdominal segments are similar, the second lobe of segments 2-6 disappearing laterally but at the meson is as long or longer than the first or third. In the description of *Calloodes greyanus*, p. 12, a sentence reads, "Cervix unarmed, also the segmental convexities"; this should be "Cervix unarmed, also the segmental sutures." The shape of the mandibles, used in the descriptions of the various *Lepidiotas*, is a variable character and on which no reliance can be placed.

Four sub-families of the Scarabæidae are represented in this present table, viz., the *Cetoniades*, *Melolonthides*, *Rutelides*, and *Dynastides*; the two species of the *Cetoniades* are at once eliminated; those representing the *Melolonthides* are then separated, the species of *Lepidiota* being divided from their smaller relations; the species of the *Rutelides* and *Dynastides* also split into two natural groups.

TABLE TO THE LARVÆ (based on Stage III. examples).

(1) Body short and stout, the head much narrower, not conspicuous, partly retracted, the legs small	= (2).
Body not short and stout, the head not much narrower, conspicuous, not retracted, the legs not small	= (3).

(2) Venter of abdomen at apex with a narrow elliptical path, open posteriorly, and bounded on either side by a row of about fourteen short stout black setæ = *Cetoniid* sp. No. 46.

Venter of abdomen at apex with a naked elliptical central space without special delimiting setæ = *Cacachroa decorticata*.

(3) Latero-cervical shield reaching farther ventrally than thoracic peritreme; apex of abdomen ventrad always with a naked path bounded by definite setæ, or with a definite formation of setæ; head always smooth or practically so; mandibles always without a small tooth just laterad of the retinaculum = (4).

Latero-cervical shield not reaching farther ventrally than thoracic peritreme; apex of abdomen ventrad without a naked path bounded by definite setæ (except in one instance); head sometimes smooth, sometimes strongly punctate or transversely wrinkled; mandibles sometimes with a small tooth just laterad of the retinaculum = (14).

(4) Anal orifice forming a straight, or nearly straight, transverse slit, without a channel joining it at meson from venter; size medium to very large (in a single case small but the stage of the larva is not known) = (5).

Anal orifice triangular, the apex posteriorly, with a median channel joining its apex from the venter; size very small to medium-small = (9).

(5) Anal path with *one convex* row of delimiting setæ; size medium = (6).
 Anal path with *one straight* row of delimiting setæ; size variable = (7).
 Anal path with *three or four* rows of delimiting setæ; size medium large = (8).

(6) Setæ bounding anal path about twelve on either side, these not dense or dark, meeting or nearly meeting across the path = *Lepidiota rothei*.
 Setæ bounding anal path twenty on either side, these dense and dark, plainly not meeting across the path = *Lepidiota* sp. No. 215.

(7) Size very large; width of head 12 mm.; epicranial sclerite finely densely rugose or coriaceous; anal path rather short, with about fourteen setæ on either side, these meeting across the path = *Lepidiota* sp. No. 45.
 Size medium large; width of head 6 mm.; clypeus and adjacent portion of epicranial sclerite finely rugose; anal path with about thirty-six setæ on either side, these stouter, adjacent, and darker = *Lepidiota* sp. No. 615.
 Size large; width of head 9 mm.; clypeus and epicranial sclerite finely alutaceous; anal path with about twenty-six setæ on either side, these shorter, not adjacent, and less dark = *Lepidiota albohirta*.
 Resembling Stage I. *albohirta* but the anterior margin of the epicranial sclerite has a row of fine setæ; setæ delimiting anal path not very fine and small = *Lepidiota* sp. No. 10.

(8) Delimiting area of setæ of anal path rather kite-shaped, prolonged anteriorly, with one of its rows produced anteriorly as far as apex of scattered setæ about it; setæ *inside* epicranial sclerite (not including those along anterior margin) 8-14 on either side; width of head, 7.5 mm. = *Lepidiota* sp. No. 683.
 Delimiting area of setæ of anal path not kite-shaped, nearly ovate, not produced anteriorly as far as apex of scattered setæ about it, with about fifty setæ on either side; setæ *inside* epicranial sclerite (not including those along anterior margin) 6-9 on either side; width of head, 6.5 mm. = *Lepidiota frenchi*.
 Delimiting area of setæ of anal path shaped as in *frenchi*, with about forty setæ on either side; the margins of the naked path quite straight; setæ *inside* epicranial sclerite (not including those along anterior margin) 4-5 on either side; width of head, 7.5 mm. = *Lepidiota caudata*.
 Delimiting area of setæ of anal path as in *caudata*, but the margins of the naked path distinctly convex; setæ *inside* epicranial sclerite (not including those along anterior margin) two on either side; width of head, 6 mm. = *Lepidiota* sp. No. 666.

(9) Apex of abdomen ventrad with a flat curved transverse bow of seta, with a naked path distad of it = (10).
 Apex of abdomen ventrad with a V-shaped row of seta, the apex proximad,

Size moderately small ; setæ in V very fine, not dense ; epicranium wholly naked ; second antennal joint with one seta dorsad and one ventrad, the antennæ otherwise naked = No. 653.

YY

Apex of abdomen ventrad with a Y-shaped row of setæ, the shaft double, thus = (11).

Apex of abdomen ventrad with a curved U of rather dense setæ, this open posteriorly = (12).

(10) Size very small ; width of head, 2 mm. ; setæ in anal bow 20-24, close, rather fine, the scattered setæ proximad of this in two irregular rows ; second antennal joint with one seta ; epicranial sclerite with a single seta on either side of meson in centre, otherwise naked = *Epholcis bilobiceps*.

Size larger ; width of head, 3·15 mm. ; setæ in anal bow eighteen, longer, stouter, darker, and close together, the scattered setæ proximad of this in about four irregular rows ; second antennal joint with two setæ ; epicranial sclerite wholly naked = No. 625.

(11) Epicranial sclerite without setæ ; second antennal joint with one seta at base ventrad, antennæ otherwise naked.

Shafts of the Y parallel, the setæ scattered, about fifteen on either side, the shafts and branches shorter ; size small ; width of head, 2·25 mm. = *Heteronyx* sp. No. 646.

Shafts of the Y diverging posteriorly, the setæ rather dense, about twenty on either side, the shafts and branches shorter ; size larger ; width of head, 3·50 mm. = No. 667.

(12) Anterior margin of epicranial sclerite with one seta only on either side of meson, the row behind this consisting of two setæ on either side of meson.

Anal row of setæ in a broad horseshoe, no longer or as long as its greatest width, the sides slightly converging posteriorly, the setæ very distinct and closely set together = *Haplonycha* sp. No. 650.

Anterior margin of epicranial sclerite with a row of setæ, behind this with a row of scattered setæ = (13).

(13) Anal row of setæ in a broad horseshoe, wider than long, the sides converging and nearly touching posteriorly, the setæ longer and denser = No. 671.

Anal row of setæ not so rounded anteriorly, its sides not converging posteriorly, distinctly longer than its greatest width, the setæ shorter and less dense = *Haplonycha* sp. No. 587.

(14) Head always more or less smooth, never strongly transversely wrinkled or punctate = (15).

Head strongly punctate, in one case transversely wrinkled = (19).

(15) Apex of abdomen ventrad with a short narrow obscure naked path bounded by about fourteen fine short non-adjacent setæ on either side ; pronotum divided into three lobes.

Pubescence of thorax dorsad very sparse ; first antennal joint without setæ, the second with four, the third with two = *Anomala australasiæ*.

Apex of abdomen ventrad without a naked path bounded by definite setæ ; pronotum divided into two lobes = (16).

(16) Cervix and segmented sutures armed more or less with fine black teeth or setæ ; apical antennal hardly as long as the penultimate, the antennæ wholly naked = (17).

Cervix and segmental sutures naked ; apical antennal joint longer than the penultimate, the second with three setæ = (18).

(17) Size smaller ; width of head, 5·25 mm. ; pubescence distinctly sparser, also teeth in cervix and segmental sutures ; mandibles without a tooth just laterad of retinaculum = *Anoplognathus* sp. No. 686.

Size larger ; width of head, 6·5 mm. ; pubescence distinctly denser, also teeth in cervix and segmental sutures ; mandibles with a small tooth just laterad of retinaculum = *Anoplognathus boisduvali*.

(18) Size larger ; width of head, 6 mm. ; mandibles without a tooth just laterad of retinaculum = *Calloodes greyanus*.
 Size smaller ; width of head, 4·5 mm. ; mandibles with a tooth just laterad of retinaculum = *Repsimus aeneus*.

(19) Head strongly transversely wrinkled = *Horonotus optatus*.
 Head punctate = (20).

(20) Second lobe of anal segment dorsad with most of its surface, raised and bounded by an oval suture ; epicranial sclerite with a row of setæ near its anterior margin, and setæ scattered over its surface ; second antennal joint with two setæ = No. 71.
 Second lobe of anal segment dorsad plain ; epicranial sclerite wholly without setæ ; antennæ wholly naked = (21).

(21) Peritremes not distinctly open ; legs not distinctly increasing in size ; whole body with very dense pubescence ; latero-cervical shield with at least several setæ along its margin ; size very large = *Xylotrupes australicus*.
 Peritremes distinctly open ; legs distinctly increasing in size ; body with much sparser pubescence, quite sparse on thorax dorsad ; latero-cervical shield with one or two setæ only along its margin ; size medium to medium large = (22).

(22) Setæ at apex of abdomen ventrad in about eight irregular rows longitudinally and transversely ; width of head, 4 mm. = *Isodon puncticollis*.
 Setæ at apex of abdomen ventrad denser, in about twelve irregular rows longitudinally and transversely = (23).

(23) Epicranial sclerite well separated from the clypeus ; latero-cervical shield with two setæ, one each on anterior and posterior margins ; second antennal joint not twice as long as greatest width ; thorax dorsad with more setæ ; width of head, 4·25 mm. = *Semanopterus depressiusculus*.
 Epicranial sclerite not well separated from the clypeus ; latero-cervical shield with one seta only, on its posterior margin ; second antennal joint over twice as long as greatest width ; thorax dorsad with less setæ ; width of head, 6·10 mm. = *Dasygnathus australis*.

THE PUPÆ.

No attempt has previously been made to separate the pupæ of the various species, but Girault has described those of *Lepidiota albohirta*, *Anoplognathus boisduvali*, and *Cacachroa decorticata*, in full. The table herewith given makes an effort to distinguish the species by recognisable characters, and also to place them, as far as possible, in their relations to each other; this has not always been effected, for though the various *Melolonthides* fall into a natural grouping, the *Rutelides* and *Dynastides* are not readily separated. Nineteen species are listed, being the pupæ of the more common soil-inhabiting scarabaeid grubs of the Cairns district. Closely allied adults would appear to have closely allied pupæ and larvae; for example, note the species of *Lepidiota*, where this hypothesis is seen to be very true.

TABLE TO THE PUPÆ.

(1) Cremaster bearing two sharp spines = (2).
 Cremaster unarmed = (10).

(2) Clypeus bidentately emarginate ; size small.
 Intermediate tarsi not attaining apex of elytra, the posterior tarsi a little shorter than their tibiæ ; elytra not attaining apex of wings = *Epholcis bilobiceps*.
 Clypeus straight or nearly = (3).

(3) Posterior tarsi longer than their tibiæ ; size moderately small.. = (4).
 Posterior tarsi distinctly shorter than their tibiæ ; size large to medium = (6).

(4) Abdomen dorsally not strongly convex ; elytra extending to apex of wings.
 Intermediate tarsi attaining apex of wings = *Heteronyx* sp. No. 646.
 Abdomen dorsally strongly convex ; elytra not extending to apex of wings = (5).

(5) Intermediate tarsi attaining apex of wings = *Haplonycha* sp. No. 587.
 Intermediate tarsi shorter, not attaining apex of wings = *Haplonycha* sp. No. 650.

(6) Outer edge of anterior tibiae without teeth ; spiracles not raised or prominent.
 Abdominal segments 3-6 ventrally with a small triangular transverse slit with serrated margins, the one on the third segment smaller ; ridges of abdominal segments 2-6 dorsally acute ; longitudinal path of irregular striae on dorsal segments 7-9 of abdomen rather broad, narrowed at base, with about 20 fine striae at its widest part ; medio-dorsal line of abdominal segments 1-6 plainly visible = *Lepidiota albohirta*.
 Outer edge of anterior tibiae with two or more teeth ; spiracles raised and prominent = (7).

(7) Abdominal segments 3-6, or at least 4-6, ventrally with a small triangular transverse mark ; medio-dorsal line on abdominal segments 1-6 more or less distinct = (8).
 Abdominal segments 3-6 without any distinctive marking ; medio-dorsal line on abdominal segments 1-6 indistinct = (9).

(8) Longitudinal path of striae on abdominal dorsal segments 7-9 rather broad, somewhat narrowed at base, with about 30 striae at its widest part ; third tooth on anterior tibiae obsolete.
 General color deep orange ; abdominal segments 2-6 dorsally more rounded, their medio-dorsal line thick and very distinct ; median marks on venter present on abdominal segments 3-6 and very dark = *Lepidiota* sp. No. 215.
 General color golden-yellow ; abdominal segments 2-6 dorsally less rounded, their medio-dorsal line fine and not very distinct ; median marks on venter present on abdominal segments 4-6 and not very dark = *Lepidiota rothei*.

(9) Ridges of abdominal segments 2-6 dorsally much rounded ; striae in dorsal path not more than eight = *Lepidiota* sp. No. 683.
 Ridges of abdominal segments 2-6 dorsally much rounded ; third tooth on anterior tibiae obsolete ; dorsal path of striae rather broad, with about twenty striae ; spines on cremaster rather long and stout = *Lepidiota caudata*.
 Ridges of abdominal segments 2-6 dorsally subacute ; third tooth on anterior tibiae small but distinct ; dorsal path of striae rather narrow, with about twelve striae ; spines on cremaster short = *Lepidiota frenchi*.

(10) Sutures between abdominal segments 1-6 or 7 dorsally without transverse carinae enclosing a cleft or sulus ; cremaster carinated dorsally along its apical margin ; latero-posterior angles of pronotum projecting into the elytra ; pronotum with a hump near latero-posterior angle = *Cacachroa decorticata*.
 Sutures between abdominal segments 1-6 or 7 with transverse darkened carinae enclosing a cleft or sulus ; cremaster not carinated dorsally along its apical margin ; latero-posterior angles of pronotum not projecting into the elytra, no hump near these latero-posterior angles = (11).

(11) Male with a distinct projection in centre of pronotum ; both sexes with a protuberance on the head ; male legs longer than those of the female ; anterior tarsi almost attaining apex of intermediate tarsi, the anterior tarsi in both sexes as long as their tibiae = *Xylotrupes australicus*.
 Male without a distinct projection in centre of pronotum ; the male sometimes with a protuberance on the head ; male legs not longer than in the female ; anterior tarsi distinctly shorter than their tibiae, and not nearly attaining apex of intermediate tarsi = (12).

(12) Intermediate and posterior tarsi as long as their tibiae.
 Latero-posterior pronotal angles subrounded ; pronotum at meson of posterior margin with a pair of small raised tubercles ; seventh abdominal segment dorsally not raised ; male without a projection on the head = *Anomala australasiae*.
 Intermediate and posterior tarsi shorter than their tibiae = (13).

(13) Pronotal angles subacute ; males without a projection on the head = (14).
 Pronotal angles broadly rounded = (15).

(14) Ninth dorsal abdominal segment with a distinct median groove
 = *Repsimus aneus*.

Ninth dorsal abdominal segment with a faint median groove at base only
 = *Anoplognathus boisdruvali*.

(15) Cremaster from dorsal aspect divided as two small semi-acute projections
 = *Isodon puncticollis*.

Cremaster from dorsal aspect more or less divided but not showing two small
 projections = (16).

(16) First dorsal abdominal segment depressed below the metanotum, the seventh
 not raised like the sixth, the ninth with a median carina ; pronotum in the
 male on two planes = *Horonotus optatus*.

First dorsal abdominal segment not depressed below the metanotum, the seventh
 raised like the sixth, the ninth without a median carina ; pronotum in the male
 convex, not on two planes = (17).

(17) Legs longer, the intermediate tarsi nearly attaining apex of elytra, the posterior
 tarsi attaining the ninth abdominal segment
 = *Semanopterus depressiusculus*.

Legs shorter, the intermediate tarsi not nearly attaining apex of elytra, the posterior
 tarsi attaining the fifth abdominal segment = *Dasygnathus australis*.

ANOPLOGNATHUS Sp. No. 686.

See table of species. Body more or less wholly white.

ISODON PUNCTICOLLIS Macleay.

Distinctly smaller than *Dasygnathus australis*, Stage III. being more nearly equal in size to Stage II. of that species. Head of a lighter colour; pubescence throughout generally finer. In most specimens examined, the mandibles bore no small tooth just laterad of the retinaculum, but this character was found in one specimen; thus the character is variable, at least in this species, though it has not been found so in any other case.

Stage III.—Width of head, 4 mm.

Stage II.—Width of head, 3 mm.

Stage I.—Width of head, 1.75 mm.

DASYGNATHUS AUSTRALIS Boisd.

The supposed Stage II. larva on which the description is based in Bulletin No. 2, is evidently a different species, possibly a Stage III. larva of *Isodon puncticollis*.

Stage III.—Width of head, 6.10 mm.

Stage II.—Width of head, 3.50 mm.

LEPIDIOTA Sp. No. 45.

There may be as many as eight setæ on the first antennal joint, and three on the second, the first of these long, the second and third short (*albohirta* may have a second short seta); there are about three irregular rows of setæ anteriorly of the anal path, which has up to sixteen delimiting setæ on either side.

Stage II.—Width of head, 6.25 mm.

LEPIDIOTA Sp. No. 615.

See table of species. Second antennal joint with three setæ, the first with six.

Part II.—Scientific Data.

The data given in Bulletin No. 2 was finished at the end of August, 1914; since then a great deal of work has been carried on, along the lines followed in the former investigation, and much additional information has been gathered, although much more has still to be learned of many of the species. No collecting has been done outside the Cairns district, and almost all our records are from the vicinity of Gordonvale.

With regard to the life cycle of the species, *Lepidiota albohirta*, *L. rothei*, *Cacachroa decorticata*, *Anomala australasiae*, and probably *Dasygnathus australis*, *Semanopterus depressiusculus*, and *Haplonycha* sp., No. 650, have a one-year life cycle; most of the others take two years.

Around Gordonvale, *Dasygnathus australis* is the earliest species to pupate and emerge, followed by *Lepidiota albohirta* and *Anoplognathus boisduvali*, with most of the others coming next in a bunch; *Lepidiota* sp., No. 215, would appear to be last. In the jungle lands of the Babinda Mill area emergence is generally earlier.

The tables of the larvae have been compiled from material gathered from August, 1914, to January, 1916; no collecting was done in July, 1915. The season 1915, on account no doubt of the unusual warmth of the months July and August, was much earlier as regards the transformation of the pupa and adult, and had rain fallen emergence would probably have been some weeks earlier. In September and October, 1914, larva was very much more plentiful than in the corresponding months of the following year.

LEPIDIOTA ALBOHIRTA Waterhouse.**THE EGG.**

Numerous females were kept separately in confinement, and given fresh food continuously; many did not deposit eggs, but the following separate numbers were obtained:—12, 13, 14, 20, 10, 15, 12, 13, 10, 12, 20, 14, 14, 25. Searching in the fields resulted only in one record, 13 eggs being found at a depth of five inches directly under a cane-plant in red volcanic soil.

THE LARVA.

In 1916, the earliest Stage I. found in the fields was on January 14th; in 1915, the first was obtained on January 4th, by the latter half of February most had entered Stage II., but the last Stage I. was taken on March 26th; the first Stage II. was found on January 16th, the Stage predominated in February and March, and the last occurred on May 29th. The earliest Stage III. was observed on February 12th in alluvial clay loam, on the 15th in dark loam, and on the 23rd in red volcanic, but the Stage did not predominate until April. In 1914, a few larvae remained in October, and the last record, of one pupating, was made on November 16th; in 1915, the last Stage III. was found on September 18th. The long period during which the adults emerged in the 1914-5 season, no doubt, would account for the correspondingly long period during which Stage I. and II. were to be found.

During the past sixteen months collecting by following ploughs resulted as follows:—September 144, October 25, November 1, December 0, January 20, February 299, March 707, April 600, May 453, June 192, August 23, September-December 0. The figures for volcanic and dark and light loam soils are nearly equal.

The species was not abnormally abundant in 1915, and on the whole cane-fields were fairly free from its depredations, but there were instances of unusually severe attacks on individual farms. For example, the estate of Greenhills, where the open volcanic soils seem to give ideal conditions for the larvæ, suffered to an extreme extent, and hundreds of acres of cane was completely killed; in the jungle lands of the Babinda Mill area serious damage was caused in several cases.

Digging in soil in jungle, Babinda, 21st September, 1914, produced a single Stage III. larva.

THE PUPA.

In 1914 the majority of the larvæ pupated during September; in 1915 pupæ were not uncommon during the latter half of August. An exceptional record is of a larva placed in confinement on April 13th, that pupated on May 30th. September and October, 1914, were remarkable for the large number of pupæ ploughed up; thus in September 140 pupæ were obtained from 86,480 yards plough furrows, in October 331 pupæ were obtained from 110,840 yards plough furrows. The comparative shallow depth at which the pupæ were found (less than eight inches) may be accounted for by the frequent showers during August and September keeping the soil moist.

Many pupæ taken from cane-fields on September 9th commenced emerging on October 2nd and continued until November 2nd, giving the maximum duration of the pupal stage as 54 days. The last pupa to emerge was on November 20th.

THE ADULT.

In 1914 the first unemerged adult was ploughed out on September 16th in red volcanic cane-field, but further specimens were not obtained under October 2nd, and by October 25th were not common; in 1915, an adult was ploughed out on July 20th, again on August 21st, and were rather plentiful by the end of September.

There appears to have been no general emergence in 1914, this being spread over several weeks. The first beetle flew to light on November 13th; on November 17th a few were noticed in a banana plantation on the banks of the Mulgrave River, and within the next weeks were plentiful in this locality (within the immediate vicinity of Gordonvale emergence occurs here first, that is from the alluvial loam cane-fields on the right bank of the Mulgrave River); on December 13th occurred the first emergence of any magnitude, and subsequently freshly emerged beetles were noted until nearly the end of January; on February 2nd a considerable emergence was reported from Aloomba; by February 16th beetles were very scarce, and the last seen was on the 20th. On January 28th ploughing in a dark volcanic cane-field yielded adults, ova, Stage I. and II. larvæ, and on February 20th ploughing in yellow clay loam fallow land produced an adult, Stage I., II., and III. larvæ.

In 1915 an emergence occurred from the alluvial loam cane-fields on November 19th, a general emergence took place on December 4th except

from the red volcanic canefields at Meringa where emergence occurred on December 12th; by the end of December beetles were comparatively few, and had practically disappeared by the middle of January. In this season the species remained an abnormal period in the ground before emerging; thus by September 30th adults were found plentifully in their pupal cells in the red volcanic soils, but emergence in this locality was not until December 4th, or over nine weeks from the date of transformation; this was no doubt due to the unusual season, the warm months of July and August causing the early transformation to the pupa and adult, while the absence of rain prevented emergence (the first rain fell on November 17th). It would seem that no emergence can happen until rain has moistened the soil.

The greatest length of life, adults from forest confined with food, was 30 days, and thus a month is the general limit. Our results show that the female lives longer than the male.

In Bulletin No. 2, p. 33, it is stated—"No food is eaten during the day, the beetles remaining hanging to the hidden and protected sides of the leaves." Feeding may continue into the morning up to 10 o'clock, and in the latter part of the afternoon especially if the day is cloudy. Among farmers and other residents one often hears the remark that the beetles are best collected in the early hours after daybreak, as later on they are not to be found; about daybreak the beetles leave their exposed positions and shelter under the leaves, or if the tree be without much shelter, they may fly to some thickly foliaged tree where they may be found in clusters in well-sheltered positions; sometimes, however, they remain feeding until the heat of the morning affects them, and in such a case if the feeding-tree be nearly bare they find such shelter as there is, under the branches for example.

Excessive heat may affect the beetles; during the last few days of December, 1914, and first few days of January, 1915, an extreme heat-wave prevailed, the shade temperature reaching as high as 103° Fahr.; in the middle of the day numbers of beetles were observed flying in the forest; being watched, they were found to alight on the trunks of the larger trees, on the side sheltered from the sun; scores were seen on a single tree, lining the trunk for from 3 to 50 feet.

Cane leaves are occasionally eaten but not to any extent.

LEPIDIOTA Sp. No. 683.

THE LARVA.

This species has been confused with *frenchi* in Bulletin No. 2; the Cooktown supposed Stage I. and II. *frenchi* belong to this species; unfortunately the Stage III. larvae from the same locality had been discarded and could not be re-identified.

Stage I. at Cooktown February 2nd, 28th; Stage II. February 8th, March 1st. At Gordonvale Stage II. has been taken on the following dates:—April 7th, 13th, 28th, May 7th, 9th, 18th, August 19th. Stage III. in November and December were in their first year's development, moulting from Stage II. in October; like *frenchi* the species has a two-year life cycle.

The larvae are not plentiful; during the past sixteen months collecting by following ploughs has resulted as follows:—September 1,

October 3, November 17, December 4, January 10, February 1, March 0, April 9, May 5, June 0, August 1, September-November 0, December 51 larvae; the 51 larvae in December were from one field. Of these larvae 93 were from loam soils and 8 from volcanic, which would show that the former kind of soil is preferred.

THE PUPA.

A Stage III. larva confined on December 22nd, pupated on October 31st and emerged December 7th, giving the length of the pupal stage as 37 days. Another Stage III. larva confined on December 4th was pupating on August 31st, and pupated on September 11th.

THE ADULT.

Mr. A. M. Lea, to whom specimens of *frenchi* and this species were sent for determination, states, in letter, 26 iv. 15, "I cannot find any specific distinctions between these specimens; those of No. 683 (C. 156) appear to be simply large females, or possibly they belong to a large race of the species." The larva and pupa both differ from *frenchi*; the adults are certainly very similar, but No. 683 is distinctly larger, of a deeper colour, the legs are of a deeper colour, and the posterior tarsi are shorter in relation to their tibiae; the species are no doubt different.

In confinement an adult emerged from the pupa on December 7th, another on October 18th. A single beetle flew to light on December 14th, 1914, and this is our sole record. Several were received from Mr. F. P. Dodd, of Kuranda, who stated that they swarmed not unplentifully at that place in December.

LEPIDIOTA FRENCHI Blackburn.

THE LARVA.

In 1915 the first Stage I. was found on February 3rd, in March they were very abundant, in April only a few were observed, and the last was noticed on May 21st; in 1916 digging at base of cane-plants yielded the first Stage I. on January 11th. The earliest Stage II. was on March 10th, and by the end of the month the majority had entered that Stage. In 1914 the first Stage II. entered Stage III. on October 29th; in 1915 the earliest was on September 26th, obviously a very early record and possibly exceptional; most of the larvae enter Stage III. during the end of October and through November, a few remaining until December, and even later; of four Stage II. found by digging at base of cane-plants in red volcanic soil, 14th January, one entered Stage III. by the end of the month, the others are still in Stage II. now (February 7th); the soil in this field had been in a very dry condition previously, and this may have retarded the growth and development of the larvae. Breeding-cages containing Stage II. confined in May and June when examined on November 1st showed mostly Stage III., a few Stage II., in cells. It is a question whether the moulting would take place in cells in the fields; however, since very few larvae were present in October, reappearing at the end of November and through December, it would seem that they seek a greater depth and thus escape the plough. Stage III. are very plentiful in December, January, and February, less so in March and April, and by May and June are seldom encountered; as they are about full-grown by February, it is probable that they finish

feeding by the end of that month and go deeper into the ground, possibly entering cells (it is known that the larva enter cells as long as four months before pupating), and hence are rarely ploughed out.

In the relative abundance of the species this comes an easy second, with 21.28 per cent. of the total. The larvæ are distributed over the past sixteen months as follows:—September 28, October 3, November 41, December 90, January 69, February 129, March 371, April 188, May 187, June 169, August 16, September 7, October 16, November 16, December 304. The numbers from forest and fallow lands and canefields are—77,545 yards plough furrows yield 496 larvæ, forest and fallow lands; 412,285 yards plough furrows yield 1,138 larvæ, canefields; or proportionately nearly 70 per cent. from the forest and fallow lands. The figures from volcanic and clay and dark loam soils show a rather greater proportion from the clay and dark loams.

The unusually large emergence of beetles in the 1914-5 season was succeeded by a corresponding large number of larvæ. In December-February, 1915-6 season, several cases came under notice where this species was causing direct injury to the cane; in one of these cases, in new forest land, second year under cultivation, young first ratoons, the cane was turning yellow and dying in some instances, and twelve stools picked at random yielded the following larvæ—2, 0, 1, 0, 3, 4, 5, 5, 0, 2, 0, 3; in a second case, in old red volcanic soil, ratoon cane stools pulled up yielded 8, 9, 4, 10, 6, 4, 8, and the roots of the plants showed direct injury.

THE PUPA.

Few larvæ were kept for rearing purposes, and little data is available as to pupation. Pupæ were taken from our rearing cages on November 2nd, 12th, and 28th; one that pupated on November 3rd emerged on December 9th, giving the duration of the pupal stage as 36 days.

THE ADULT.

In confinement the first adult emerged on December 9th.

In the 1914-5 season vast numbers emerged; the first emergence was recorded on December 28th, and during the week following thousands were flying and swarming at dusk in canefields. The flight commenced earlier than with *albohirta*, and lasted for about twenty minutes; afterward mated pairs were found attached to cane leaves, but the great majority had betaken themselves to the neighbouring forest where the humming of their flight was audible among the tree tops until 8 p.m. when observations were discontinued. Later, on January 23rd-31st, another large emergence occurred, the beetles being present in the same fields as during the earlier emergence, and enormous numbers were swarming over the grass plots in the township, hundreds of mated pairs being observed clinging to fence posts, wire fencing, low shrubs, &c.; after the end of January only a few beetles were present, and by February 10th they had disappeared. An adult was ploughed up on February 23rd, another on March 10th. In the 1915-6 season, the species was not nearly so plentiful; a few were first observed on December 8th, and again on the 10th, emergence being general by the 15th. In all the swarming noticed, mating occurred almost invariably within three feet of the ground, and when mating in company with *rothei* and No. 215, these latter species were always at a greater height.

The only food plants known are the bloodwood (*Eucalyptus* sp.) and Moreton Bay ash (*Eucalyptus tessellaris*). The beetles do not remain on the feeding-trees during the day; probably they re-enter the soil, and in this habit are followed by *rothei* and others; in fact, of the species of *Lepidiota* the only one to remain among the foliage in the day time is *albohirta*.

LEPIDIOTA ROTHEI Blackburn.

THE LARVA.

Stage I. has been recorded on March 28th; Stage II. on April 7th, 13th; May 7th, 9th, June 9th. In October, 1914, and less so in September and November Stage III. larvae were plentiful, but in the following season were comparatively scarce; in October, 1914, 328 larvae were taken from one field, the crop cane and weeds, the soil verging from yellowish loam to volcanic. Omitting these larvae the numbers from volcanic and loam soils are 19 and 209 respectively, the species being very uncommon in true volcanic soils. Full-grown Stage III. larvae remaining after the middle of December invariably proved to be attacked by a Dipterous parasite. The life cycle lasts one year.

THE PUPA.

In confinement, the larvae pupated during the latter half of November and first half of December. In the fields two pupae were found on November 26th. The pupal stage is of about 24 days' duration.

THE ADULT.

The first adult emerged from the pupa in the first week of December. In 1914-5 season, the first emergence took place on December 28th, the beetles swarming plentifully on that date and for several days afterwards; in the 1915-6 season, a single beetle was noticed on December 11th, and a general emergence occurred on December 19th. The species swarms around shrubs or even tall trees; when swarming in company with *frenchi* they were not found mating among the cane but on low trees in the adjoining forest.

LEPIDIOTA Sp. No. 215.

THE LARVA.

Stage II. has been found on the following dates:—April 30th, September 4th, 19th, 27th, October 29th, November 5th and 16th; Stage III. on January 18th, February 5th, March 10th, 15th, 26th, April 2nd, September 3rd, 7th, 11th, 19th, 23rd, October 2nd, 5th, 28th, November 20th. In confinement, several Stage II. confined in September and October were still in that Stage in January; another confined on September 19th entered Stage III. on October 17th; still another confined on September 27th entered Stage III. January 4th-20th. Thus, unlike its ally *rothei*, this species has a two-year life cycle.

Twenty-six larvae were obtained during September-November, 1914, and only eight subsequently. The number from volcanic and loam soils is about equal, but proportionately to the length of plough furrows nearly 92 per cent. are from forest and fallow lands.

THE PUPA.

In confinement the first pupa was noticed on December 3rd, and the remainder throughout that month. In four records kept, the duration of the pupal stage was from 27-30 days.

THE ADULT.

Mr. A. M. Lea of the South Australian Museum, to whom specimens were sent for determination, states, in letter 26 IV. 15—"These agree closely with our co-type of *Lepidiota rothei* and are certainly that species. The four specimens of No. 215 differ from the four specimens of *rothei* sent, in being larger, more shining, abdomen more rotund and more sparsely clothed, and in the deeper notch to the clypeus, but these are all possibly sexual differences. Without being absolutely certain as to the mating of the sexes of both forms, it would be inadvisable to describe No. 215 (C. 137) as a new species, or even as a variety." There is not the slightest doubt that the species are distinct, the larva, pupa, and adult all showing well-marked differences, and moreover the life cycle of this species is two years, of *rothei* one year.

The first adult emerged from the pupa on January 1st, thence throughout that month, the last being reared on January 24th.

In 1915, the first emergence occurred on January 25th, after heavy rain, thousands of beetles swarming over a grass plot in the township, in company with *frenchi*, and this continued for several nights, numbers of mated pairs being found clinging to leaves of shrubs at a height varying from 4-10 feet; general swarming ceased by February 1st, but a few mated pairs were obtained until February 14th. On the first night of the emergence many were attracted to artificial lights, but none were present on the subsequent nights of the swarming. In the 1915-6 season, no large emergence was observed; a few flying on January 21st being the only record.

This species is thus the last of the *Lepidiotas* to emerge.

LEPIDIOTA Sp. No. 45.

THE LARVA.

A Stage II. larva was found by digging in a garden, Kuranda, 10th July, 1915; it had moulted to Stage III. by July 20th. Ploughing in a yellow clay loam canefield, Harvey's Creek, 13th September, 1915, produced a Stage II. and a Stage III. larva. Digging caneholes, six inches deep, in recently cleared jungle land, yellow clay loam, October 12th, 1914, resulted in the finding of another Stage III. larva.

Thus it is evident that the species frequents the jungle lands.

LEPIDIOTA FROGGATTI Macleay.

Two adults caught at lights in a dwelling on a cane-farm, jungle, Harvey's Creek, 12th December, 1914.

LEPIDIOTA Sp. No. 615.

Three larvae, probably in Stage III., found by digging in almost pure sand, bed of Mulgrave River, 27th August, 1915. The larvae were not bred to maturity.

LEPIDIOTA Sp. No. 10.

These are the supposed Stage I. larvae of *albohirta* from soil near roots of cane, Finchhamton, Mackay, 17th October, 1911, mentioned in Bulletin No. 2, p. 21, with a footnote calling attention to its being a distinct species.

LEPIDIOTA CAUDATA Blackburn.**THE LARVA.**

Common in the jungle canefields in the Babinda Mill area, where it is probably as plentiful as *albohirta*, and no doubt causes as much damage, but very little data relating to the species have been gathered. The Stage II. and III. larvae from Babinda, mentioned in Bulletin No. 2, p. 36, as *frenchi*, were this species.

The stages have been found on the following dates:—Stage II., January 27th, September 28th; Stage III., January 28th, September 10th, 27th, October 12th. Like *frenchi*, Stages II. and III. are found throughout the year, and the species has a two-year life cycle. Stage III. larvae found on September 28th had recently moulted from Stage II.

The species is without doubt a native of the jungle lands. Digging cane-holes in yellow clay loam, recently cleared jungle, produced Stage III. larvae in their second year of development and pupae, on September 28th; thus the land was uncleared at the time of egg-laying and for twelve months afterwards. The records from the Babinda district are all from yellow clay loam, but no collecting has been made in other soils. The species has also been taken in cultivated and garden fields not uncommonly at Kuranda.

THE PUPA.

Pupæ have been obtained on the following dates:—September 10th, 28th, October 12th, November 16th, in natural habitats at a depth of not more than six inches.

THE ADULT.

A cage containing Stage III. larvae placed there on February 11th, when opened on the 15th September, contained freshly-emerged adults. Beetles have been noted on the wing on the following dates:—September 10th, 29th, October 10th, 12th, December 5th. The September records are early and few emerge in that month; thousands emerged on October 10th; and on December 5th a number were observed swarming and mating, evidently a fresh emergence. Nothing is known as to the habits of the adults, but the species appears to feed on the foliage of jungle trees at night and to hide in the day.

The unemerged adult has a distinct bluish gloss on the elytra.

ANOPLOGNATHUS Sp. No. 686.**THE LARVA.**

Found in the jungle cane-lands of the Babinda Mill area where it is by no means common. Stage III. larvae have been obtained on the following dates:—September 10th, 21st, 28th, October 12th, all from yellow clay loam. A Stage III. larva found on September 28th had

recently moulted from Stage II., which would serve to show that the species has a two-year life cycle. It is a native of the jungle, as Stage III. larvæ in their second year of development have been found by digging cane-holes in recently cleared jungle land.

THE PUPA.

In confinement larvæ pupated on September 16th, November 3rd. One that pupated on the former date emerged on October 7th, giving the duration of the pupal stage as twenty-one days.

THE ADULTS.

Our only record is of an emergence on October 10th.

ANOPLOGNATHUS POROSUS Dalman.

Adults have been taken at Gordonvale as follows:—At light in the township, November 20th; on foliage of *Eucalyptus platyphylla* in company with *boisduvali*, November 21st; at light-trap in canefield, December 11th; single specimens in each case, and the species is without doubt very rare in this district.

ANOPLOGNATHUS BOISDUVALI Boisd.

THE EGG.

Three eggs were found by following plough in a dark volcanic cane-field, January 28th; they emerged on February 10th. Two eggs from a similar situation on February 25th emerged on March 12th.

THE LARVA.

Stage I. larvæ have been collected on December 21st, February 21st, April 8th. Larvæ hatched on February 10th were still in Stage I. by March 11th. The Stage III. found in November and December had recently moulted from Stage II. On December 26th Stage II. were obtained that had just moulted from Stage I.

Collecting by following ploughs during the last sixteen months has resulted as follows:—September 78, October 16, November 4, December 7, January 2, February 14, March 172, April 181, May 138, June 44, August 53, September 1, October 15, November 13, December 3, larvæ; or 741 larvæ out of a total of 7,678, that is 9.65 per cent.

It falls fourth in the list; in canefield collections it is fourth, in forest and fallow lands third; in volcanic soil collections it is third also, and in clay and dark loams fourth. In confinement they are very susceptible to attacks of the *Metirrhizium* fungus.

THE ADULT.

In 1914 the first adult was observed on November 15th, and by November 21st were throughout the forested areas; in 1915 the first recorded date was November 23rd, and a few were noted through the forest on December 2nd. The species has not seemed as plentiful by far as in former years. At Babinda, 1915, adults were noticed on October 13th; this district is purely jungle and there is no forest for miles.

A further food-plant must be recorded; on 21st January, a number of beetles were found feeding on the tender foliage of young bloodwoods; a fire had previously spread through this locality, and the beetles were no doubt attracted by the extreme tenderness of the young leaves, as ordinarily this is not a food-plant.

CALLOODES PUNCTULATUS Oll.

The adults of this species are not uncommon in the jungles of the Cairns district. One food-plant only is known, a shrub or small tree with dark green rough leaves; large numbers of the beetles collect on one tree and quickly defoliate it; they remain on the upper surface of the leaves in the day time, and a sharp jar causes them to fall to the ground.

On November 25th, eighteen males, thirteen females, were placed in a cage for breeding purposes; from these eighty-eight eggs were obtained, which produced seventy-two larvae; the young larvae were placed in damp sifted soil in a flower-pot, but all died within a month.

No. 653.

A single supposed Stage II. larva of this species was found in a collection from roots of native grasses, rich black loam soil, Cooktown, 9th March, 1914.

No. 625.

A single larva from under roots of *Imperata* grass, black loam soil, foot of Mount Pyramid, Gordonvale. This is the sole record.

CETONID Sp. No. 46.

A single larva in Stage III. was obtained by digging in an alluvial sandy rubbish heap, banks of Mulgrave River, 16th November, 1914; it had pupated in an earthen cocoon by December 3rd. A second Stage III. larva was found in a similar situation, 17th September, 1915. This species has a peculiar method of locomotion; only with great difficulty can it travel on its venter on a flat surface, but turning on its back it moves with freedom and even rapidity by quick contortions of the body.

CACACHROA DECORTICATA Macleay.

Stage I. has been found on January 18th, March 15th; Stage II. on January 18th, February 23rd, March 1st, 5th, April 27th; Stage III. as early as February 1st, and not again until March 4th, the latest on November 6th.

The larvae were found almost equally in volcanic and loam soils; the records from canefields and forest and fallow lands are—77,545 yards plough furrows, forest and fallow lands yielded 59 larvae; 412,285 yards plough furrows, canefields yielded 64 larvae; or proportionately nearly 80 per cent. from the forest and fallow lands.

Larvae in their pupating cocoons have been seen as early as May 21st, but they had not pupated by August 24th.

THE PUPA.

A recently formed pupa was taken from a breeding cage, September 24th.

THE ADULT.

In the 1914-5 season, beetles were not numerous; a few were seen flying in the forest during the end of December and in January; on January 30th a number were observed on flowers of *Tristania*. In the 1915-6 season, the first adult was noticed on December 3rd, and on the 8th large numbers were on the wing.

ANOMALA AUSTRALASIAE Blackburn.

THE LARVA.

Stage I. larvae have been obtained on December 29th; Stage II. on January 30th, March 2nd, 5th, 18th, April 16th; Stage III. throughout the year. Collecting in the past sixteen months at Gordonvale has resulted as follows:—September 5, October 4, November 1, December 3, January 6, February 0, March 117, April 3, May 4, June 11, August 0, September 2, October 0, November 2, December 0, larvae; of the March larvae 98 came from two fields. As regards soil, of this number 137 were from red volcanic, 14 from clay and dark loams, and 7 from alluvial sandy loam. Stage III. larvae found on January 30th had recently moulted from Stage II. Stage III. larvae are parasitized to a considerable extent, the parasite causing the host to delay its pupating for as long as several weeks, and thus full-grown larvae can be found some time after the majority have pupated. The life cycle is probably one year.

Other records of larvae are—Digging in pure jungle, Babinda, yellow clay loam, September 10th, one Stage III.; digging cane-holes, recently cleared jungle land, depth six inches, yellow clay loam, Harvey's Creek, October 12th, one Stage III.

THE PUPA.

All records from larvae kept in confinement. The first pupa was obtained on October 31st, then through November to the middle of December. Of five instances of which record was kept, the duration of the pupal period was 17, 18, 19, 19, 21 days. A Stage III. larva found on January 28th pupated on February 18th and emerged March 7th, but this is an exceptional case.

THE ADULT.

Actual emergence from the pupa first occurred on November 21st in confinement. In 1914, the first emergence was noticed at Harvey's Creek on December 13th, and on the 14th at Gordonvale, and from then swarming was often observed until the middle of January; in 1915 no large emergence was noted, the first adult being seen on November 23rd. The beetles swarm over low shrubs and trees, and exude a sweetish scent which is distinctly noticeable in the air about them and which remains on the hand for a considerable time when a swarming beetle has been captured. A few specimens have been captured at light. No food-plants have been recorded, but two adults were taken from flowers of the Leichhardt-tree, apparently feeding on the honey.

REPSIMUS AENEUS Fabr.**THE LARVA.**

Stage II. were obtained on the following dates:—October 1st, 3rd, 7th, November 3rd, December 23rd, January 30th, February 24th, August 19th. Stage III. larvae recently moulted from Stage II. were taken on January 30th. Thus the life cycle lasts for more than one year.

Most of the larvae were found in alluvial sand loam, a few in almost pure sand; a single Stage III. was collected by following a plough in a dark loam lowland canefield, May 9th, the soil containing sugar-refuse manure.

THE PUPA.

Several pupæ in November from alluvial sandy loam.

THE ADULT.

Adults were occasionally captured at lights in the end of December and throughout January. A single beetle was taken in company with *Anoplognathus boisduvali* eating foliage of the bloodwood (*Eucalyptus*), 22nd January, 1915, and another clinging to leaves of sugar-cane in a field. On 30th January, 1915, beetles were not uncommon on young foliage of bloodwood on lower slopes of Mount Pyramid.

ISODON PUNCTICOLLIS Macleay.**THE LARVA.**

This species has been confused with *Dasygnathus australis* in Girault and Dodd's paper, and many of the Stage II. records given of that species may belong to this.

Stage I. has been found on the following dates:—November 7th, 24th, December 10th, 19th; Stage II. on September 24th, October 28th, November 3rd and 7th; Stage III. on April 13th, June 16th, September 2nd, 24th, October 6th, 28th, November 3rd, 7th, December 2nd.

The larvae are usually found in patches, several such patches being present in the one field, while the soil between may be quite free from their presence. Of the number collected 97 were from volcanic soils and 3 only from the dark loams, and the species evidently favours the volcanic soils; several were also collected in one lot from an alluvial sandy loam rubbish-heap with weeds growing on the surface.

Stage III. larvae on October 28th had recently moulted from Stage II.

THE PUPA.

Pupæ have been obtained on the following dates:—September 24th, December 3rd, 21st, January 18th; on the latter date several were taken from a breeding cage.

THE ADULT.

In confinement adults emerged December 11th, October 10th. Odd individuals have been captured at lights October 23rd, December 12th, 16th, 20th, March 5th; digging in sand river-bed on August 16th produced a single beetle; one flew to light, Harvey's Creek, October 10th.

XYLOTRUPES AUSTRALICUS Thomson.

THE LARVA.

The following records have been made from canefields:—Ploughing in cane, black loam soil, soil containing sugar-refuse manure, May 9th, produced 8 Stage III., 1 Stage II.; ploughing in cane, dark loam soil, June 9th, yielded 1 Stage III., 1 Stage II.; ploughing in cane, red volcanic soil, gave 1 Stage III. In the case of the first record the sugar-refuse manure probably accounted for the presence of the larvæ.

THE ADULT.

First emergence was observed on November 16th, a male flying to light, and from that date until the middle of January beetles were caught at lights on a number of occasions. At Kuranda during the latter half of February, many beetles were seen on young branches of *Poinciana* and *Philanthus*.

HORONOTUS OPTATUS Sharp.

THE LARVA.

Stage II. larvæ were found in August, September, and October; many Stage III. in the latter had recently moulted from Stage II., and as no Stage II. were obtained in November, all must have entered Stage III.

THE PUPA.

In confinement the first pupa was taken on November 18th, and many were found until the end of that month and throughout December.

THE ADULT.

The first unemerged adult was obtained in confinement on December 9th. Beetles flew to lights on January 5th, March 22nd, April 9th and 16th. Digging in sand, August 16th, yielded a single beetle.

DASYGNATHUS AUSTRALIS DEJEANI Macl.

THE EGG.

A female beetle ploughed up in a canefield was placed in damp sifted soil in confinement; on the 18th November the cage was examined finding fourteen eggs; these hatched between November 26th and December 5th, thus giving the duration of the egg stage as at least seventeen days.

THE LARVA.

The larvæ of both *Isodon puncticollis* and *Semanopterus depressiusculus* have been confused with this species in Bulletin No. 2, and the Stage I. and II. records given therein are valueless.

Two recently hatched larvæ placed in damp sifted soil on December 3rd entered Stage II. between January 1st and February 5th; thus Stage I. was of 56-71 days' duration. Stage II. larvæ were first recorded on December 3rd; in January they were more plentiful than Stage III.; in February 23 per cent. were in Stage II.; in March only a very few remained in this Stage, the last being found on March 31st. The first

Stage III. was found on December 26th, and in January 43 per cent. were in this Stage; larvae were found in cells as early as May 31st, and had all pupated by the beginning of September, the few that were taken subsequently invariably proving to be parasitized.

The duration of the life cycle has not been definitely decided, but is probably one year, since no Stage II. larvae were obtained after March; if this hypothesis is true, it is hardly accountable that larvae could have reached Stage III. by December 26th; on the other hand Stage III. of *Cacachroa decorticata*, which emerges several weeks after this species, have been recorded as early as February 1st.

Collecting by following ploughs in the past sixteen months has yielded larvae as follows:—September 3, October 5, November 1, December 8, January 182, February 197, March 213, April 156, May 122, June 23, August-December 0; or 910 larvae out of a total of 7,678, that is 11.85 per cent, falling third in the list. In canefield collections it is third, in forest and fallow lands fifth; in volcanic soil collections it is seventh, and in dark and clay loams third. In the dark loam soils it is plentiful, only a small percentage of the total coming from volcanic soils. The larvae are also frequently found in alluvial sandy loam rubbish-heaps.

THE PUPA.

In 1914 the first pupa was obtained on August 29th; in 1915 they were plentiful in our breeding cages by August 16th; thus the species is the earliest to pupate. An exceptional record is of a pupa found on May 20th.

THE ADULT.

The earliest adult emerged from the pupa on September 14th, 1914; in 1915 they emerged by the end of August. Beetles have occurred in canefields, following ploughs on the following dates:—September 24th, October 27th, November 2nd, 4th, 11th, 19th, 26th, December 6th; these were no doubt emerged specimens that had re-entered the soil to hide.

On November 18th and 29th numbers were noticed flying in a cane-field at dusk, red volcanic soil; several caught all proved to be females.

PENTODON AUSTRALIS Blackburn.

An adult caught at light, Gordonvale, 3rd January.

CHEIROPLATYS Sp. C. 123.

A single adult captured at light, 14th December, Harvey's Creek.

SEMANOPTERUS DEPRESSIUSCULUS MacL.

THE LARVA.

All the larvae from Gordonvale were collected in alluvial sandy loam rubbish-heaps. At Babinda, on 21st September, 1914, ploughing in a clay loam jungle canefield produced 2 Stage III., and again at Harvey's Creek ploughing in a similar situation yielded 2 Stage III. Since all those found in the last six months of the season were in Stage III., it would seem that the species has a one-year life cycle.

THE PUPA.

The first larva pupated on September 10th, then on October 4th, 10th, November 1st and 6th. In seven cases the length of the pupal stage was as follows:—23, 22, 19, 18, 18, 18, 20 days.

THE ADULT.

Unemerged adults were first obtained in confinement on October 3rd, but the majority emerged during November. Odd beetles were caught at lights during December. A single beetle flew to light at Kuranda, 3rd August, 1915.

HAPLONYCHA Sp. No. 650.

THE LARVA.

Stage II. were obtained in August. Of four Stage II. larvae collected on August 18th two had entered Stage III. by August 31st, the other two by September 14th. Several Stage III. recently moulted were observed in the first half of September. A breeding cage was placed in the ground on May 21st, and was left uncovered for a few days; it was opened on October 31st when several Stage III. larvae and adult remains of this species were found; the cage was quite secure and the beetles had evidently entered it within a few days of May 21st; thus the larvae have reached Stage III. in less than five months, which serves to show that the species has a one-year life cycle.

Stage III. larvae have been collected by following ploughs in the last sixteen months as follows:—September 127, October 16, November 31, December 1, January-April 0, May 1, June 2, August 52, September 9, October 0, November 1, December 0. Of this number 8 only are from volcanic soil, 215 from clay and dark loams, which shows that the species favours the loam soils.

THE PUPA.

The first pupa was obtained in our breeding cages on November 2nd, but the majority pupated toward the end of that month and in the beginning of December. In the fields the sole record is of a pupa on November 19th.

THE ADULT.

Adults were first found in our breeding cages on November 12th, but the greater number did not emerge until the beginning of December. The first emerged beetles flew to light on January 5th, again on the 27th; after that date beetles were frequently taken at lights until the end of May. An adult was caught at light, Halifax, Herbert River, March 26th, 1914; they were swarming plentifully around low shrubs, Kuranda, at the end of February.

HAPLONYCHA Sp. No. 587.

THE LARVA.

Seventeen Stage II. larvae were collected in September, 1914, also 31 Stage III., 5 Stage III. in October, 4 Stage III. in November, and 1 Stage III. in March, 1915. A Stage II. larva found on September 4 moulted to Stage III. on October 15th. A recently moulted Stage III. was noticed on November 6th. The life cycle probably extends for two years. Of the 58 larvae collected 45 were from forest and fallow lands; 47 were from clay and dark loam soils.

THE PUPA.

Pupae have been obtained in confinement on September 28th, October 26th, 31st, November 10th, December 2nd and 6th. A pupating larva was collected in a canefield, November 17th.

THE ADULT.

Unemerged adults have been taken in confinement on October 25th, November 7th, December 9th. Adults have flown to lights on January 15th and 30th.

HETERONYX Sp. No. 646.

Stage II. has been recorded on January 28th, May 18th, June 4th; Stage III. on September 8th, 14th, 24th, October 2nd, 8th, February 12th, 16th, 23rd, June 15th, August 19th, 23rd, December 3rd. The species is rare.

THE PUPA.

A larva in confinement pupated between September 22nd and October 7th, a second between October 14th and November 2nd.

THE ADULT.

An adult reared from a pupa in confinement, October 12th; another adult found in one of our rearing cages, August 16th.

EPHOLCIS BILOBICEPS Fairm.

THE LARVA.

Thirty-five Stage III. larvae were collected by following ploughs in dark loam soils, September, 1914, and one in March, 1915; no others were obtained.

THE PUPA.

In confinement pupæ were found on November 5th, 26th, and 30th.

THE ADULT.

An adult emerged in confinement on December 3rd, and a second on December 16th. First taken at lights on January 26th, and from that time until the end of March. Several beetles collected under bark of *Eucalyptus platyphylla* in forest, 12th April.

Part III.—Natural Enemies.

A number of natural enemies of the various cane-grubs are known, and there are no doubt many more to be discovered. However, the sum-total of the grubs destroyed is very small, as none of the parasitic or predaceous enemies are at all plentiful. The natural enemies can be divided into five groups as follows:—(1) The internal larval parasites, comprising the various Diptera of the family Dexiidae; (2) the external larval parasites, comprising three species in the Hymenopterous family Scoliidae; (3) the predaceous Dipterous larvae of the family Asilidae; (4) the predaceous Coleopterous larvae of the family Elateridae, of which one species only is known; (5) the internal adult parasites, comprising one, perhaps two, species of Diptera.

THE SCOLIID PARASITES.

The three scoliid parasites known to attack the cane-grubs are *Dielis formosa* Guérin, *Discolia soror* Smith, and *Campsomeris radula* Fabr.; the first-named has long been known as an enemy of *Lepidiota albohirta*, the other two have been discovered by this laboratory. The larva attaches itself to its host on the venter of the thorax or basal abdominal segments where it remains until full-grown, finally spinning a cocoon and pupating against the skin of its victim. Little has been learnt as to the habits of the species; it would seem that *Dielis formosa* is the most common in canefields, and *Discolia soror* in sand or sandy loam; as they probably have similar habits, the data for the three are taken together.

Experiments have been tried to effect the breeding of the parasites in confinement, but without success. On June 25th a female *Campsomeris radula*, caught on flowers, was placed in a bottle containing a Stage III. larva of *Anoplognathus boisduvali* in about an inch of soil; in a few minutes the wasp attacked the larva, holding it by an anterior leg, the larva meanwhile making frantic efforts to seize its enemy which after a short delay stung its victim on the venter of the first thoracic segment and paralysed it immediately; the wasp now attempted to bury the larva, catching it by the mandibles for this purpose, but the depth of earth being insufficient, again seized it by an anterior leg and remained for some time with the tip of its body against the venter of the thorax of the larva as though ovipositing; however subsequent examination revealed no trace of an egg, and if deposited it must have been internally; the larva did not recover from the attack, remaining in a limp paralyzed state merely feebly moving its mouth-parts until July 20th, when it commenced to turn black from the anal end and to decompose a few days after. A second female of the same species was confined on the same date in a similar manner with a Stage III. larva of *Lepidiota caudata*; the actions of the wasp in attacking the larva were exactly alike except that no short delay occurred after the victim was seized before it was paralyzed; the larva in this case died within a day or two. On November 29th, a female *Dielis formosa* was captured and placed in a glass jar containing two Stage III. larvae of *Lepidiota caudata*; both were paralyzed the same day, one died on the following date, the other remained limp and inactive until December 20th when it commenced to shrivel and was dead on the 22nd. On August 19th a Stage III. *Anoplognathus boisduvali* larva was ploughed up, attached to which was a small Scoliid larva, which at once became detached; the host remained inactive until October 24th when it began to shivel and was dead on the 27th. These records show that the larva does not recover from the attack of the wasp though it may remain alive for some considerable time; in this respect one is reminded of the paralyzing of spiders, caterpillars, &c., by the Pompilidae and Eumenidae. Tryon (Queensland Agric. Journal, vol. x., No. 2, 1902) states as regards the attack of the larva of *D. formosa*, "for, notwithstanding the fact that the beetle-grub continues for a while to feed, its body gradually becomes more or less flaccid and collapses." From our observations above-mentioned, this statement of the host grub continuing to feed would appear incorrect; moreover it is natural to suppose that in moving through the earth a healthy grub would soon dislodge its external parasite, and we cannot see how the parasite could remain attached to its host under such conditions.

Tryon states that the larva of *D. formosa* "may attain its maximum development within a fortnight or less." We have not gathered any data on this subject, but that the duration of the stage is short is shown by the following record:—On September 27th five Stage III. larvae of *Lepidiota caudata* were placed in a rearing cage sunken in earth, and were then of course quite healthy; the cage was opened on November 16th, finding 1 pupa, 2 dead larvae, and 2 cocoons with *Dielis formosa* pupæ attached to the remaining larval remains in the pupating cells; thus the *Dielis* had attained this stage of development within 50 days. Also, as in two cases mentioned above, paralyzed larvae remained alive for less than four weeks, the parasite larva probably attains its full size within that time.

Four hosts are known—viz., *Lepidiota rothei*, *L. albohirta*, *L. caudata*, and *Anoplognathus boisduvali*.

Larvae have been recorded as follows:—14th June, *D. formosa*, taken from cocoons; 28th May, full-grown larva attached to Stage III. *Anoplognathus*, spun cocoon within twelve hours; 27th October, full-grown *Discolia soror* on host, 1½ feet deep in sand, spun cocoon on following day; 10th September, full-grown larva on Stage III. *Lepidiota albohirta*; 14th September, full-grown larva on Stage III. *Anoplognathus*; 19th August, small larva on Stage III. *Anoplognathus*.

The earliest record of a cocoon is that of a *Campsomeris radula* attached to Stage III. *L. albohirta* on 27th April. The length of the pupal stage, or rather the period spent in the cocoon, varies considerably, and sometimes this may last for four or five months. A cocoon of *C. radula* found on April 27th emerged on July 22nd, or 86 days; a *D. soror* cocoon spun on October 28th emerged on December 7th, or 40 days; another cocoon of *D. soror* found on June 29th emerged November 11th, or 135 days, and a third found on August 19th emerged December 11th, or 114 days. The majority of the pupæ emerge during November and December, and there is also a considerable emergence in June and July, which would appear to agree with Tryon's conclusion that there are two broods in the year. Adults are seen in smaller or greater numbers throughout the year; *Campsomeris radula* has been captured in numbers in June and October, and *Discolia soror* swarms plentifully in November on shrubs on the banks of the Mulgrave River. A female *Dielis formosa* was noticed standing over a paralyzed Stage III. *Lepidiota albohirta* in canefield May 26th.

A cocoon containing a larva found in a canefield September 3rd was kept in confinement; the larva is still alive and not pupated now, on February 14th; that is, it has remained in this dormant state for 164 days.

During July, August, and September, numerous Stage III larvae of *Lepidiota rothei* were placed in our rearing cages; the cages were opened in December, when it was found that some of the larvae had succumbed to Scoliid parasites, of which nine were obtained. These all produced male *Dielis formosa*, and from this record interesting deductions can be made. The male *Dielis formosa* is much smaller than the female; also *rothei* is a small larva, and would not furnish enough sustenance to produce the large female Scoliids. Hence it is probable that all *Dielis formosa* obtained from *rothei* would be males; then are males ever bred

from larger hosts as *L. albohirta* or would the greater amount of nourishment necessarily yield the females? We believe that this phenomenon of the food supply regulating the sex of an insect, where great disparity occurs in the size of the sexes, has been recorded by other writers.

THE SCOLIID HYPERPARASITES.

The Scoliids themselves are in their turn attacked by two parasites, a coleopteron and a dipteron.

MORDELLID Sp. C. 109.

This little beetle has been recorded thrice as a parasite of the Scoliidae. On December 1st, 1914, an adult emerged from a Scoliid cocoon taken from a canefield; on January 7th, 1915, a dead adult was found in the host cocoon from canefields; on October 9th, 1915, one was bred from a cocoon of *Discolia soror*. An adult was captured on leaves of sugar-cane, November 27th, 1914. At what stage in the life of the Scoliid is it attacked by its parasite?

BOMBYLID Sp. D. 22.

This fine fly is common around Gordonvale in December, January, and February, where it may be seen hovering over fields, roadways, etc. It has been bred from Scoliid cocoons on the following dates:—November 20th, December 6th and 26th. The larva pupates loosely within the host cocoon. Pupæ have been taken from the cocoons in October.

THE DEXIID PARASITES.

Several flies of the family *Dexiidae* are known to attack the various Searabæid larvæ; a single parasite emerges from the host; only Stage III. has been found parasitized; in most cases the host larva lingered on for some weeks after the normal time of pupating before succumbing. None of the flies are common, and the percentage of larvæ destroyed by them is decimal.

DEXIID Sp. D. No. 4.

A dull species with bluish reflections that is often taken in summer around the laboratory building. It has been bred on four occasions, as follows:—From Stage III. *Dasygnathus australis*, 18th March, 1915; from puparium in black loam canefield, 18th March, 1915; from Stage III. *Dasygnathus*, 12th August, 1915; from Stage III. *Anoplognathus* sp. No. 686 found in yellow clay loam jungle canefield September 14th, parasite pupated between November 24th, December 8th, emerged December 19th, 1915. Thus the two known hosts are *Dasygnathus australis* and *Anoplognathus* sp. No. 686.

DEXIID Sp. D. No. 23.

A bright blue-green species, the abdomen partly black, that has been noticed on tree-trunks in the forest and on fence-posts during November and December. It has been reared on three occasions, and always from Stage III. *Dasygnathus australis*. The records are—Host found in red

voleanic canefield, October 23rd, 1914, parasite pupated between January 7th, 21st, emerged February 1st; host from red voleanic canefield, October 27th, parasite pupated between October 28th and November 14th, emerged November 24th, 1914; pupated between January 11th and 20th, emerged January 27th, 1916.

Dasygnathus pupates by the end of August, and these records are all of larvae that have been hindered from pupating by the presence of the parasite.

DEXIID Sp. D. No. 33.

A beautiful brilliant light green species, the head yellow, the abdomen with two or three black bands. The following records:—Adult taken on floor of laboratory, 17th December; adult caught at light, September 10th; one reared from Stage III. *Anomala australasiae* found in dark voleanic fallow field, March 26th, formed puparium between April 9th and 16th, emerged May 6th; reared from Stage III. *Horonotus optatus* from sand in river bed, December 14th. An empty puparium found in a breeding cage containing Stage III. *Horonotus optatus*, December 19th, is possibly referable to this species.

D. No. 4, No. 23, No. 42, No. 47, No. 33, are typical looking Dexüds probably belonging to *Putilia* or an allied genus.

DEXIID Sp. D. No. 15.

A rather small greyish species with long slender legs, possibly belonging to the genus *Myocera*; it has been reared on one occasion, one being bred from Stage III. *Haplonycha* sp. No. 587, October 20th, 1914.

DEXIID Sp. D. No. 32.

A closely allied species to the foregoing, and a parasite of *Anomala australasiae* larvae. Of 29 larvae placed in confinement in the latter half of 1914, 11 died naturally, 7 pupated, and 11 were killed by this parasite; of 11 larvae confined in 1915, 7 pupated, 3 died naturally, and 1 was killed by this parasite; the percentage of parasitism would therefore appear to be great. Puparia have been found in confinement on November 26th, December 3rd, 8th, 10th, January 20th, and emergence occurred from early in December to early in February. An adult was caught on window of laboratory September 14th. Adults of this or an allied species have been noticed on tree-trunks in the forest.

DEXIID Sp. Unknown.

The following records of puparia that were not reared are probably referable to either D. No. 4 or D. No. 23, possibly to both:—(1) From Stage III. *Dasygnathus* taken from dark loam canefield November 10th, puparium found December 23rd, 1914; (2) from Stage III. *Dasygnathus* confined in rearing cage May 26th, a larva and puparium of parasite found December 8th, 1915; (3) a puparium found in dark loam canefield February 19th, 1915, prevalent larvae being *Dasygnathus* Stage III. mostly, *Anoplognathus* Stage III., *L. frenchi* Stage III., *L. albohirta* Stage II. and III.; (4) from Stage III. *Dasygnathus* found in sandy loam February 19th, 1915, puparium found February 26th; (5) from

Stage III. *Dasygnathus* confined in a breeding cage May 7th, removed and kept indoors on September 18th, dead on April 1st with the parasite larva within, a puparium on April 6th; in this case the host remained alive seven months after the normal time of pupating.

DEXIID Sp. D. No. 42.

A dull species with greenish reflections, reared on two occasions as follows:—One reared from Stage III. *Lepidiota rothei* taken from dark loam canefield October 6th, placed in breeding cage, removed and kept indoors December 19th, puparium formed between February 4th and 8th, emerged February 25th; bred from Stage III. *L. rothei* found in red volcanic canefield, February 11th, formed puparium between February 26th, March 4th, emerged March 20th.

DEXIID Sp. D. No. 47.

Resembles the preceding species but with a larger head; it has been recorded once, one being reared from Stage III. *Lepidiota frenchi* taken from red volcanic canefield February 8th, formed puparium between March 4th and 11th, emerged March 27th.

THE PREDACEOUS ASILIDÆ.

Larvae of four species of the dipterous family Asilidæ, of which three have been reared, are known to attack the various cane-grubs. These larvae move freely through the soil, and, finding a cane-grub, bury their head in some soft portion of its body and so suck it to death; they pupate loosely in the soil. Owing to the softness of their body they are frequently bitten and killed by their prey. None of the species are common, and hence do little material good.

ASILID Sp. D. 1.

The largest species and most abundant in canefields. Large larvæ have been taken on the following dates:—June 4th, July 30th, September 24th, October 5th, November 4th; from red volcanic canefields, from yellow clay loam grass lands, and from loam jungle canefield. Pupæ have been taken in confinement as follows:—Pupated between October 18th and 26th, emerged November 28th; pupated between December 7th and 14th, emerged January 17th; pupated between November 22nd and 29th, emerged December 30th; pupated January 3rd, emerged February 3rd; pupated September 17th. The length of the pupal stage is somewhat over a month. The adult is a large typical Asilid, of a dull colour, the femora and tibiæ deep-red, the tarsi black.

ASILID Sp. D. 65.

A medium-sized species; the adult is somewhat yellowish, the legs black with the tibiæ yellow. A number of larvæ were taken from red volcanic soil, badly infested with cane-grubs, June 16th and July 30th, also two larvæ from dark loam canefield, August 22nd. Pupæ have been found in confinement on the following dates:—August 19th, 22nd, September 9th, 10th, 16th, 25th; one that pupated on September 10th emerged on October 5th, giving the duration of the pupal stage as 25 days.

ASILID Sp. D. 48.

A rather small species; the adult is somewhat yellowish, the legs wholly yellow. A number of larvae was taken from red volcanic soil badly infested with cane-grubs, July 7th; three pupated between November 29th and December 14th, two emerged on December 23rd, the third on December 26th. An adult was captured on leaves of sugar-cane, March 27th.

ASILID Sp. No. 1139.

This fourth species is a long slender larva, very different from the other three. One only has been found, from red volcanic fallow field, May 20th; it was kept in confinement and died on January 2nd; during its period of confinement it killed the following larvae:—4 Stage II. *L. frenchi*, 5 II. *Anoplognathus*, 2 III. No. 650, 1 II. and 1 III. *Isodon puncticollis*.

THE DIPTEROUS ADULT PARASITES.

A small brown dipteron with a dark head (D. 6) has been bred from *Lepidiota albohirta* adults. One was reared in February, 1914, but the species was not again recorded until December, 1915, when a number of beetles of those brought in and kept in confinement were killed by this fly; in some cases one or two parasites emerged from the host, but from eight to twelve was the general rule; the dead hosts when handled easily fall in pieces, unlike the beetles that have died naturally; the parasites pupate in the abdomen of the host.

A common grey and black Sarcophagid (D. 13) is suspected of being a second adult parasite of *albohirta*; it has been reared on more than one occasion, but there was no absolute certainty that the eggs had not been deposited in the beetles after death.

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